DATA EVALUATION RECORD

Chemical Code 129057 STUDY 3

CHEM "Ag-Cu Zeolite"

Harris, J.C. 1990. Leaching of Silver and Copper from Impregnated Polymers. Conducted by Arthur D. Little, Inc., Cambridge, MA; Completed 7/30/90 (Draft), 8/3/90 (Final); ADL #63614-04; ADL MSS #63614-01. Submitted by Kanebo Zeolite USA, Inc., New York, NY.
MRID #41615818

Loveday, K.S. 1992. Leaching Study with BACTEKILLER AC. Performed by Arthur D. Little, Cambridge, MA; Completed 2/4/92. Submitted by Kanebo Zeolite USA, Inc., New York, NY.
MRID #42245401

REVIEWED BY: S.C. Termes, Chemist
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CONCLUSIONS

It should be clear that this study is not a 163-1 study (Mobility in Soils), but rather a special study conducted to attempt evaluating the amount of silver and copper "leached" from three different "Ag-Cu Zeolite" impregnated polymeric materials.

The reviewed study provides only ANCILLARY information. The registrant must respond to the comments in the REVIEWER'S COMMENTS section.

Although the study appears to indicate that the different polymeric matrices and the manner in which the "Ag-Cu Zeolite" is introduced into the matrix affect the amount of silver and copper leaching. However, the study fails to address if there is also "leaching" of the "Ag-Cu Zeolite" from the treated matrix in conjunction with silver and copper.

Only three polymeric matrices (polyester, polyester/cotton and polypropylene) were considered. It is not clear at this point which other matrices will also be treated with "Ag-Cu Zeolite" and at which Maximum Inhibitory Concentration (MIC) on a dry basis of the finish products. The reviewed study would only support the polymeric materials used in the study at 1.5% MIC.

MATERIALS AND METHODS

Test Material: "Ag-Cu Zeolite" provided by sponsor, containing 3.4% Ag and 6.1% Cu on a dry weight basis.

Incorporation of the "Ag-Cu Zeolite" into the Polymers: The three polymeric matrices to which the "Ag-Cu Zeolite" was incorporated (at 1.5% by weight anhydrous) were,

a. "PE"= Non-woven polyester fabric (polyethylene terephthalate)
b. "PC"= Zeolite-treated polyester fabric blended with cotton at a 1:1 ration by weight. Woven Sheeting.
c. "PP"= Polypropylene plate.

The polymer matrices were prepared as indicated on page 11 of the report. However, it is not clear from the report how the zeolite was actually incorporated.

Control Samples: Negative and positive control samples were prepared. The negative control sample was the leaching medium (ASTM Type I water, a nichrome wire and glass beads. The positive control samples were 5 ppb (ug/L) of Ag and 25 ppb (ug/L) of Cu prepared from standard solutions (counter anion not specified) in leaching medium, nichrome wire and glass beads.

Test System: The samples were protected from irradiation and temperature controlled (25±1 C, except for day 8-12 period in which the temperature dropped to 23.4 C). Agitation was accomplished with magnetic stirrers.

The "coupons" (i.e, treated polymeric materials) had the dimensions of 1.7 cm x 1.7 cm (±0.1 cm) for a total surface area (2-sides) 6 cm^2 per coupon. The coupons were assembled as shown in Fig. 1. The leaching medium was 30 mL ASTM Type I water. The initial pH of the leaching medium was measured with narrow-range pH paper. During the initial assemblage of the "PP" coupons, residues of 10% nitric acid rinse were noticed; these plates were rinsed until the pH of rinsate was >6 prior to use.

Sampling Intervals: 0, 1, 2, 4, 8 and 15 days.

Analytical Methodology: After the leachates were removed, they were chilled prior to opening; the pH was measured (pH paper) and a measured quantity of concentrated HNO_3 added to bring the pH <2. Samplpes were stored in the dark at 4 C.

Ag and Cu in the filtered leachates (0.45 ug Teflon filters) were determined by Graphite Furnace Atomic Absorption (GFAA). Calibration curves and calculated sample concentrations were based on the average height of the GFAA peak for two sequential analysis of each sample or diluted sample. The Level of Quantitation (LOQ) for Ag was 0.15 ppb and 4.0 ppb for Cu.

REPORTED RESULTS:

The results show no clear time-dependent leaching of Ag or Cu from the "Ag-Cu Zeolite" treated polymeric matrix. In all cases, the pH of the initial leachate ranged 4.5-5.5 (initial) to 6.0-6.8 (final).

The range of quantities of Ag (corrected) and Cu released under the conditions of the study were,

Polymeric Material	Ag (ug/g)	Cu (ug/g)
Polyester/Cotton (woven)	4.2 - 12.3	47 - 137
Polyester (Non-woven)	5.5 - 8.2	46 - 75
Polypropylene Plate	ND - 0.15	ND - 0.16

The maximum concentrations of metals in the leachates (corrected for Ag recovery were,

Polymeric Material	Ag (ug/L)	Cu (ug/L)
Polyester/Cotton (woven)	16 (15 d; pH 6.0)	210 (4 d; pH 6.5)
Polyester (Non-woven)	35 (0 d; pH 5)	345 (15 d; pH 6.5)
Polypropylene Plate	8.9 (1 d; pH 6.0)	9.3 (1 d; pH 6.0)

Results from spiked samples indicated that there was irreversible losses of silver, which the author attributed to adsorption.

No actual studies were conducted for leaching of Ag and Cu from "Ag-Cu Zeolite"- impregnated polymeric materials. The author (MRID #42245401) relied on data from the "Hydrolysis" study (MRID #41613816) to estimate the amount of silver and copper released at pH 7 and 9. These estimates are presented in Appendix C (silver) and Appendix D (copper).

REVIEWER'S COMMENTS:

1. While the study attempts to present the release of Ag and Cu from polymeric materials impregnated from "Ag-Cu Zeolite", it does not address the possibility that the "Ag-Cu Zeolite" per se could also come out (as a solid phase) from the impregnated material. This possibility should be addreseed by the registrant, with data presented to support their argument.

2. In this study as well as in the "hydrolysis" studies, the author argues that the low recovery of Ag is likely due to adsorption to the vessels. However, no conclusive data has been presented to demonstrate this argument.

3. While Ag and Cu were determined by Graphite Furnace Atomic Adsorption in this study, the "Hydrolysis" and "Photolysis" studies used Inductively Coupled Argon Plasma to determine Ag and Cu concentrations. No rationale for the change of analytical methodology (or the advantages of one method to the other) was presented by the author.

4. An increase of 1 to almost 2 pH units was observed between the initial and final leachates.

5. From the information presented, it appears that the method of incorporation of the "Ag-Cu Zeolite" into the polymeric matrix may affect the leaching of Ag and Cu from the treated matrix. For example, it appears that the use a extruder kneading may result in less leaching than when mixer kneading is used. However, subsequent processes after incorporation are also likely to affect the leachability of Ag and Cu fro the treated polymeric material. Surface analytical methods (such as Scanning Electron Microscopy/EDAX) may be more suitable to better characterize treated polymeric matrices before and after exposure.

6. The procedure for estimating the amount of silver and copper from the impregnated polymeric material at pH 7 and 9 is not clear. Note that the pH of impregnated materials in the submitted study in which the initial pH was ca. 5 increased about 1-2 units when placed in water. Unlike data presented in MRID #41615818, in which leaching in terms of percent on a unit weight/area basis was presented, the estimates in #42245401 are not presented on the same basis. It is difficult, therefore, to evaluate the value of the estimates for pH 7 and 9.

7. It is not clear at this point which are the polymeric materials to be treated with "Ag-Cu Zeolite". The reviewed study was conducted with only three polymeric materials (polyester, polyester/cotton and polyethylene) at a Maximum Inhibitory Concentration of 1.5% (dry weight basis of finish products).

3. Materials

3.1 Test Substances

The experimental materials were provided by the study sponsor, Kanebo Zeolite USA. The sponsor assumed responsibility for performing analyses to determine the homogeneity and stability of the test material in addition to supplying information on the characterization of the material.

The materials investigated during this study have been determined by the sponsor to have the following characteristics:

Composition: Silver copper zeolite of the formula: $(X_1Na_2O{\cdot}X_2Ag_2O{\cdot}X_3CuO){\cdot}Al_2O_3{\cdot}YSiO_2{\cdot}ZH_2O$, where X_1, X_2, X_3, Y, and Z represent the number of units of each component in the zeolite structure.

According to the study sponsor, the zeolite contains 3.4% silver and 6.1% copper on a dry weight basis.

Polymers: The zeolite was incorporated into three polymer matrices which were:

Material PE
- Polyester Non-woven Fabric (Study sponsor sample code E-1) - Polyethylene terephthalate staple fiber incorporated with silver copper zeolite at 1.5% by weight (anhydrous) by mixer kneading.
  Fiber denier: 1.5d
  Fiber Cut length: 1.5 inch
  Non-woven production: carding and needle punching.
  Non-woven weight:130g/m^2

Material PC
- Polyester/Cotton Woven sheeting (Study sponsor sample code E-2) - Polyethylene terephthalate staple fiber incorporated with silver copper zeolite at 1.5% by weight (anhydrous) by mixer kneading.
  Fiber denier: 1.5d
  Fiber Cut length: 1.5 inch
  Polyester fiber blended with cotton (no zeolite) at 1:1 by weight.
  Sheeting production: polyester and cotton blending. Fiber opening: carding, drafting, yarn spinning, weaving (the same yarn for warp and weft), scouring, bleaching, dyeing and drying.

Material PP
- Polypropylene plate (Study sponsor sample code E-3) - Polypropylene plate of polypropylene incorporated with silver copper zeolite at 1.5% by weight (anhydrous) by extruder kneading.
  Plate preparation by injection molding.

Figure 1: Schematic of Test Coupon Assembly for Leaching Study

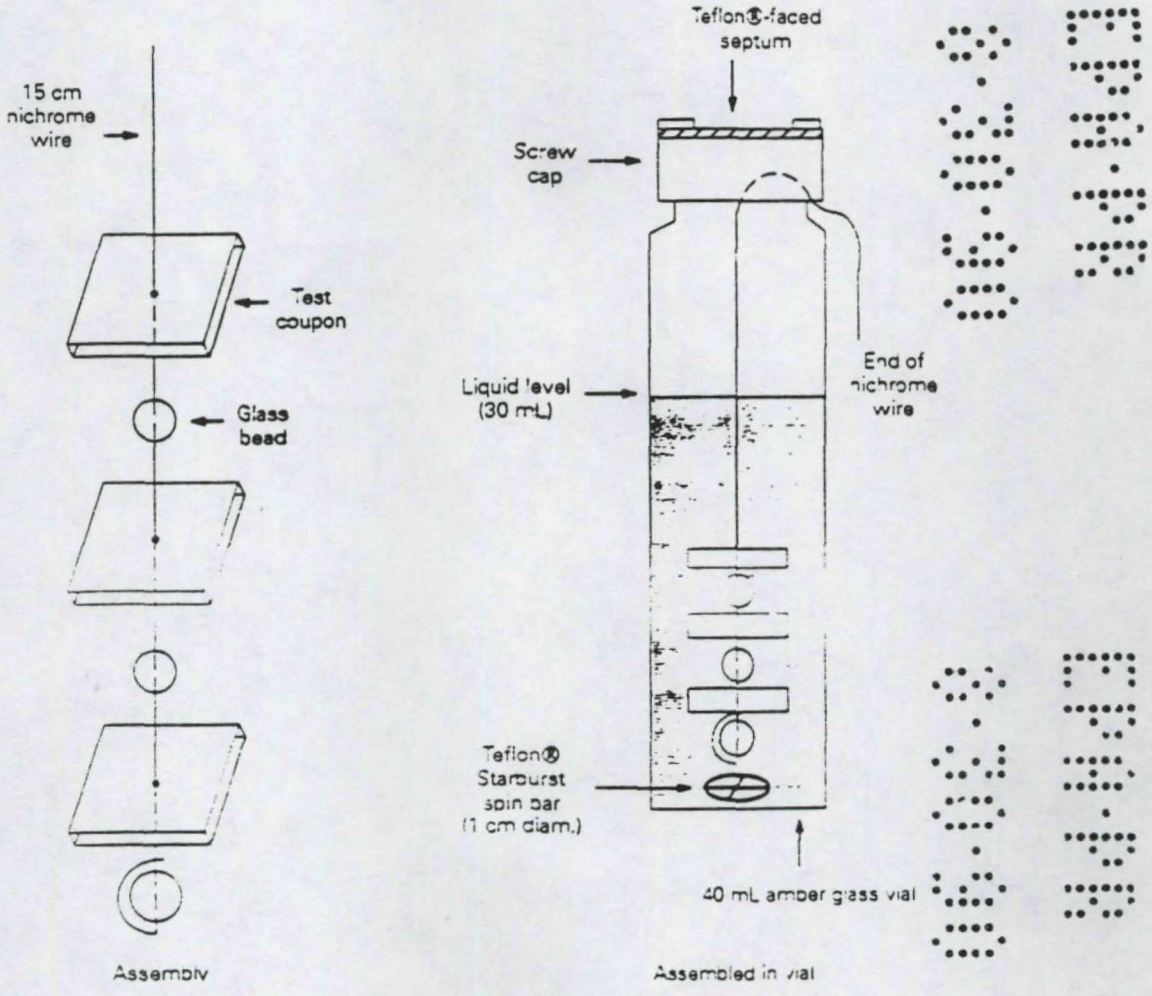

Table 1: Results for Leaching Study Blank Samples

BLANK	TEST DAY	AG,PPB	CU,PPB
B-8	0	<0.15 (0.066)	<4.0 (ND)*
B-1	1	<0.15 (0.046)	<4.0 (ND)
B-2	2	<0.15 (0.048)	<4.0 (0.85)
B-3	4	<0.15 (0.056)	<4.0 (ND)
B-4	8	<0.15 (0.064)	<4.0 (ND)
B-7 (REP)	8	<0.15 (0.068)	<4.0 (ND)
B-5	15	<0.15 (0.092)	<4.0 (ND)

* ND = Not detected; response in laboratory blank range

Table 2: Results for Analysis of Leaching Study Positive Controls

Spike level = 5 ppb silver, 25 ppb copper

		SILVER			COPPER		
SAMFLE	TEST DAY	FOUND ug/L	% RECOVERY	LOSS ug	FOUND ug/L	% RECOVERY	LOSS ug
C-8	0	1.1	22	0.117	21	84	0.120
C-1	1	0.24	5	0.143	22	88	0.090
C-2	2	<0.15 (0.09)	2	0.150	22	88	0.090
C-3	4	<0.15 (0.12)	2	0.150	21	84	0.120
C-3 (DUP)*	4	<0.15 (0.09)	2	0.150	20	80	0.150
C-4	8	2.5	51	0.075	21	84	0.120
C-5	15	<0.15 (0.10)	2	0.150	23	84	0.120
C-7 (REP)*	15	<0.15 (0.07)	1	0.150	22	88	0.090
AVERAGE			11	0.134		85	0.112

* DUP = Analysis of replicate aliquot from same vial
REP = Analysis of replicate vial

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Table 3: Results for Analysis of pH 7 Hydrolysis Study Positive Controls (Silver)

Spike level = 25 ppb silver

SAMPLE	TEST DAY	FOUND ug/L	% RECOVERY	LOSS ug
C-7-8	0	20.1	80.4	0.147
C-7-1	1	17.6	70.4	0.222
C-7-2	2	19.2	76.8	0.174
C-7-3	4	18.8	75.2	0.186
C-7-4	8	18.0	72.0	0.210
C-7-5	15	15.9	63.6	0.273
C-7-7(REP)*	15	13.6	54.4	0.342
C-7-7(DUP)*	15	14.3	57.2	0.321
AVERAGE			68.8	0.234

* (REP) = Analysis of replicate vial
(DUP) = Analysis of replicate aliquot from same vial

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Table 4:Coupon Weights and Areas for Polyester/Cotton Leaching Tests

	COUPON WEIGHT (mg)				COUPON AREA (cm2)*
SAMPLE	#1	#2	#3	TOTAL	TOTAL
PC-1	13.1	13.2	12.3	38.6	17
PC-2	12.4	24.2	19.5	56.1	17
PC-3	13.2	20.7	19.3	53.2	17
PC-4	18.9	16.8	23.4	59.1	17
PC-5	12.8	13.0	13.6	39.4	17
PC-6	12.6	18.2	20.3	51.1	17
PC-7	19.9	14.4	19.8	54.1	17
PC-8	12.5	21.1	19.9	53.5	17

* 3 Coupons x 2 sides x 1.7 cm x 1.7 cm

Table 5: Silver and Copper Concentration Data for Polyester/Cotton Leachates

SAMPLE	INIT pH	TEST DAY	TEST DATE	FINAL pH	ASSAY DATE	SILVER PPB (MEAS)	SILVER RPD (%)	COPPER PPB	COPPER RPD (%)
PC-8	5.0	0	May 3	6.8	May 18	3.1		84	
PC-1	5.0	1	May 4	6.0	May 18	4.6	2.2	161	8.4
PC-1 (DUP)*	5.0	1	May 4	6.0	May 18	4.7		148	
PC-2	5.0	2	May 5	6.8	May 18	9.6	134	178	59
PC-7 (REP)*	5.0	2	May 5	6.5	May 18	1.9		97	
PC-3	5.0	4	May 7	6.5	May 18	5.6		211	
PC-4	5.0	8	May 11	6.5	May 18	2.1		116	
PC-5	4.5	15	May 18	6.0	May 21	10.0		180	

* (DUP) = analysis of a relicate aliquot from the same vial
(REP) = analysis of a replicate vial

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Table 6: Silver Leached from Polyester/Cotton Material on a Unit Weight/Area Basis

SAMPLE	TEST DAY	SILVER ppb (meas)	ppb (corr) **	ug/g	ug/cm2	% of Total ***
PC-8	0	3.1	9.3	5.2	0.016	2.0
PC-1	1	4.6	10.8	8.4	0.019	3.3
PC-1 (DUP)*	1	4.7	10.9	8.5	0.019	3.3
PC-2	2	9.6	15.8	8.9	0.028	3.5
PC-7 (REP)*	2	1.9	8.1	4.5	0.014	1.8
PC-3	4	5.6	11.8	6.7	0.021	2.6
PC-4	8	2.1	8.3	4.2	0.015	1.7
PC-5	15	10.0	16.2	12.3	0.029	4.8
RANGE				4.2-12.3	0.014-0.029	1.7-4.3
MEAN				7.3	0.020	2.9
STANDARD DEVIATION				2.7	0.0055	1.1
RELATIVE STANDARD DEVIATION, %				37	27	38

* DUP = Analysis of replicate aliquot from same vial
REP = Analysis of replicate vial

** Corrected for observed average loss of silver at pH 6-7, equivalent to 6.2 ppb.

*** Total Silver = wt. of polymer x 1.5% zeolite by weight x 3.4% silver in zeolite x 0.5 (1:1 fiber blend; no zeolite in cotton)

Table 7: Copper Leached from Polyester/Cotton Material on a Unit Weight/Area Basis

		COPPER			
SAMPLE	TEST DAY	ppb	ug/g	ug/cm2	% of Total **
PC-8	0	84	47	0.15	10.3
PC-1	1	161	125	0.28	27.4
PC-1 (DUP)*	1	148	115	0.26	25.1
PC-2	2	178	100	0.31	21.9
PC-7 (REP)*	2	97	54	0.17	11.8
PC-3	4	211	119	0.37	26.0
PC-4	8	116	59	0.20	12.9
PC-5	15	180	137	0.32	30.0
RANGE			47-137	0.15-0.37	10.3-30
MEAN			95	0.26	21
STANDARD DEVIATION			36	0.078	7.8
RELATIVE STANDARD DEVIATION			38	30	38

* DUP = Analysis of replicate aliquot from same vial
REP = Analysis of replicate vial

** Total Copper = Wt. of polymer x 1.5% zeolite by weight x 6.1% copper in zeolite x 0.5 (1:1 fiber blend; no zeolite in cotton)

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Table 8: Coupon Weights and Areas for Non-Woven Polyester Leaching Tests

	COUPON WEIGHT (mg)				COUPON AREA (cm2)*
SAMPLE	#1	#2	#3	TOTAL	TOTAL
PE-1	41.9	37.5	51.2	131	17
PE-2	39.8	36.1	35.3	111	17
PE-3	49.3	32.5	36.5	118	17
PE-4	44.2	49.4	48.1	142	17
PE-5	43.9	51.3	42.4	138	17
PE-6	41.8	36.3	38.5	117	17
PE-7	42.8	35.9	37.3	116	17
PE-8	49.3	48.7	50.1	148	17

* 3 Coupons x 2 sides x 1.7 cm x 1.7 cm

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Table 9: Silver and Copper Concentration Data for Non-Woven Polyester Leachates

SAMPLE	INIT pH	TEST DAY	TEST DATE	FINAL pH	ASSAY DATE	SILVER PPB (MEAS)	RPD or RSD %	COPPER PPB	RSD %
PE-8	5.5	0	May 3	6.5	May 18	32	16	222	5
PE-8 (DUP)*	5.5	0	May 3	6.5	May 21	25		**	
PE-8 (DUP)*	5.5	0	May 3	6.5	May 18	34		234	
PE-8 (DUP)*	5.5	0	May 3	6.5	May 21	25		**	
PE-1	5.0	1	May 4	6.5	May 18	15	32	168	44
PE-7 (REP)*	5.0	1	May 4	6.3	May 18	28		263	
PE-7 (DUP)*	5.0	1	May 4	6.3	May 21	19		**	
PE-2	4.5	2	May 5	6.8	May 18	26	17	249	
PE-2 (DUP)*	4.5	2	May 5	6.8	May 21	22		**	
PE-3	5.0	4	May 7	6.5	May 18	26	31	276	
PE-3 (DUP)*	5.0	4	May 7	6.5	May 21	19		**	
PE-4	5.5	8	May 11	6.0	May 18	20	5	256	
PE-4 (DUP)*	5.5	8	May 11	6.0	May 21	19		**	
PE-5	5.0	15	May 18	6.5	May 21	20		345 **	

* (DUP) = analysis of a replicate aliquot from the same vial
(REP) = analysis of a replicate vial

** Leachates analyzed on May 21 were at a 1:50 dilution. Copper was diluted down to the detection limit range.

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Table 10: Silver Leached from Non-Woven Polyester Material on a Unit Weight/Area Basis

SAMPLE	TEST DAY	SILVER ppb (meas)	SILVER ppb (corr) **	ug/g	ug/cm2	% of Total ***
PE-8 (ave)*	0	29	35	7.1	0.062	1.4
PE-1 (ave)*	1	21	27	6.2	0.047	1.2
PE-2 (ave)*	2	24	30	8.2	0.053	1.6
PE-3 (ave)*	4	23	29	7.3	0.051	1.4
PE-4 (ave)*	8	20	26	5.5	0.046	1.1
PE-5	15	20	26	5.6	0.045	1.1
RANGE				5.5-8.2	0.045-0.062	1.1-1.6
MEAN				6.6	0.051	1.3
STANDARD DEVIATION				1.1	0.006	0.21
RELATIVE STANDARD DEVIATION				16	12	16

* (ave) = Arithmetic Mean of Values in Table 9

** Corrected for average loss of silver at pH 6-7, equivalent to 6.2 ppb.

*** Total silver = weight of polymer x 1.5% zeolite by weight x 3.4% silver in zeolite

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Table 11: Copper Leached from Non-Woven Polyester Material on a Unit Weight/Area Basis

SAMPLE	TEST DAY	COPPER ppb	ug/g	ug/cm2	% of Total ***
PE-8 (ave)*	0	228	46	0.40	5.1
PE-1 (ave)*	1	216	49	0.37	5.4
PE-2 (ave)*	2	249	67	0.43	7.4
PE-3 (ave)*	4	276	70	0.48	7.7
PE-4 (ave)*	8	256	54	0.44	5.9
PE-5	15	345	75	0.60	8.2
RANGE			46-75	0.37-0.60	5.1-8.2
MEAN			60.4	0.45	6.6
STANDARD DEVIATION			12.0	0.08	1.3
RELATIVE STANDARD DEVIATION			20	18	20

* (ave) = Arithmetic Mean of Values in Table 9

*** Total copper = weight of polymer x 1.5% zeolite by weight x 6.1% copper in zeolite

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5.5 Results of Leaching Tests for Polypropylene Plate Material

The weights (measured) and areas (calculated) of the polypropylene plate test coupons in each test vial are listed in Table 12. The tabulated areas are based on measurement of the length (l), width (w) and thickness (d) of each coupon, taking into account that both faces plus the edges of the coupons were exposed to the leaching medium. Thus, the area was calculated as:

$$A\ (cm^2) = \underset{(faces)}{2 \times l \times w} + \underset{(edges)}{2 \times (l + w) \times d}$$

There is approximately 1% variability in the total weight and 3% variability in the total area for these test vials.

Since 30 mL of leaching medium was added to each vial, the ratio of leachate to polypropylene plate material was approximately 0.02 mL/mg or 1.6 mL/cm^2.

Table 13 presents the results of the pH measurements and silver concentration determinations for the polypropylene plate leaching tests. Table 14 shows the results for copper. Column headings are as described for Table 5 (Section 5.3). A low pH was intially observed for these samples.

The silver and copper results presented in Tables 13 and 14 show generally low, but variable, concentrations. For 3 of 7 samples in this set, the measured concentrations of both silver and copper were below the analytical level of quantification (which were 0.15 and 4 ppb for silver and copper, respectively). The Day 1 sample analysis showed approximately 2.5 ppb of silver and 9.2 ppb of copper. Also, the replicate Day 4 sample showed 7.4 ppb of copper, and the Day 2 sample showed 0.4 ppb of silver.

When the silver concentrations are corrected for recovery and the data are converted to a unit weight/unit area basis, the maximum leached quantities (Day 1 data) are calculated as:

Silver		Copper	
0.15 µg/g	0.014 µg/cm^2	0.16 µg/g	0.015 µg/cm^2

Table 12: Coupon Weights and Areas for Polypropylene Plate Leaching Tests

	COUPON WEIGHT (g)				COUPON AREA (cm2)*
SAMPLE	#1	#2	#3	TOTAL	TOTAL
PP-1	0.5643	0.5648	0.5755	1.70	18
PP-2	0.5616	0.5492	0.5652	1.68	18
PP-3	0.5514	0.5737	0.5472	1.67	18
PP-4	0.5635	0.5615	0.5448	1.67	19
PP-5	0.5470	0.5584	0.5660	1.67	19
PP-6	0.5668	0.5619	0.5614	1.69	19
PP-7	0.5613	0.5660	0.5839	1.71	19
PP-8	0.5642	0.5763	0.5564	1.70	19

* 3 Coupons x (2 surfaces + 4 edges)

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Table 13: Silver Concentration Data for Polypropylene Plate Leachates

SAMPLE	INIT pH	TEST DAY	TEST DATE	FINAL pH	ASSAY DATE	SILVER PPB (MEAS)			RPD %	PPB (CORR) ***
PP-8	5.0	0	May 3	6.8	May 18	<0.15	(0.03)			<6.2
PP-1	5.0	1	May 4	6.0	May 18	2.3			16	8.5
PP-1 (DUP)*	5.0	1	May 4	6.0	May 21	2.3				8.5
PP-1 (DUP, 1:10)*	5.0	1	May 4	6.0	May 21	2.7				8.9
PP-2	5.0	2	May 5	6.5	May 18	0.41			3	6.6
PP-2 (DUP)*	5.0	2	May 5	6.5	May 18	0.42				6.6
PP-3	5.0	4	May 7	6.5	May 18	<0.15	(0.05)			<6.2
PP-7 (REP)*	5.0	4	May 7	6.5	May 18	<0.15	ND	**		<6.2
PP-4	5.0	8	May 11	6.5	May 18	0.17				6.4
PP-5	5.5	15	May 18	6.5	May 21	<0.15)	(0.09)			<6.2

* (DUP) = analysis of a replicate aliquot from the same vial
(REP) = analysis of a replicate vial

** ND = Not detected; sample response in laboratory blank range.

*** Corrected for average loss of silver at pH 6-7, equivalent to 6.2 ppb.

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Table 14: Copper Concentration Data for Polypropylene Plate Leachates

SAMPLE	INIT pH	TEST DAY	TEST DATE	FINAL pH	ASSAY DATE	COPPER PPB		RPD %
PP-8	5.0	0	May 3	6.8	May 18	<4.0	(0.32)	
PP-1	5.0	1	May 4	6.0	May 18	9.1		2
PP-1 (DUP)*	5.0	1	May 4	6.0	May 21	9.3		
PP-1 (DUP, 1:10)*	5.0	1	May 4	6.0	May 21	ND	**	
PP-2	5.0	2	May 5	6.5	May 18	<4.0	(1.7)	
PP-2 (DUP)*	5.0	2	May 5	6.5	May 18	<4.0	(2.7)	
PP-3	5.0	4	May 7	6.5	May 18	<4.0	(0.44)	
PP-7 (REP)*	5.0	4	May 7	6.5	May 18	7.4		
PP-4	5.0	8	May 11	6.5	May 18	<4.0	(2.9)	
PP-5	5.5	15	May 18	6.5	May 21	<4.0	(2.6)	

* DUP = analysis of a replicate aliquot from the same vial
(REP) = analysis of a replicate vial

** ND = Not detected; sample response in laboratory blank range.

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6.0 Conclusion

- The results of this study show no clear time-dependence (over a 15-day period) of the leachability of silver and copper from polymers impregnated with silver copper zeolite.
- The results for positive controls indicate that irreversible losses of silver occurred; this resulted in a practical level of detection for silver of about 6.2 ppb compared to the analytical detection limit of 0.15 ppb.
- The range of quantities of silver (after correction for recovery) and copper (µg/g of polymer) released under conditions of the study were:

Material	Silver (µg/g)	Copper (µg/g)
Polyester/Cotton	4.2 - 12.3	47 - 137
Non-woven Polyester	5.5 - 8.2	46 - 75
Polypropylene Plate	ND - 0.15	ND - 0.16

- The maximum concentrations of metals in the aqueous leachate after correction for silver recovery were:

Material	Silver (µg/L)	Copper (µg/L)
Polyester/Cotton	16	210
Non-woven Polyester	35	345
Polypropylene Plate	8.9	9.3

- The concentrations of silver and copper in the leachates generated in this study are below the U.S. EPA drinking water guideline (50 µg/L) for silver and the ambient water quality criterion (1000 µg/L) for copper.